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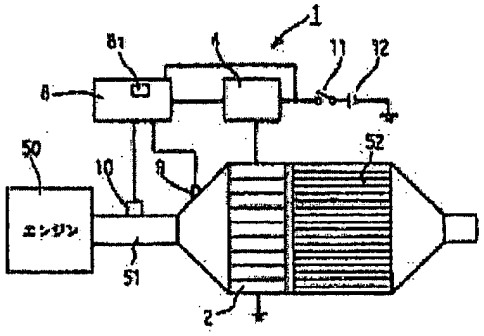
(54) EXHAUST GAS PURIFIER OF INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an exhaust gas purifier of an internal combustion engine 1 capable of improving the purification efficiency of the exhaust gas by effectively supplying electric power to the electric discharge part.
SOLUTION: In this controller 8, the mean electron energy obtained from each component e (electron quantity) at a discharge field, V (electric voltage value applied between the surface parts of each discharge part opposing with each other), λ (free path of electron) and Gap (distance between the surface parts of each discharge part opposing with each other) is taken into consideration and the mean electron energy at 6 eV as the reaction energy enough to generate a plurality of kind of radicals including O radical requiring the purification of the exhaust gas is provided. V is determined to be the mean electron energy 6 eV from a map data of the temperature, the pressure and V at the discharge field 7 satisfying the mean electron energy 6 eV previously stored in a first memory part 8a and each signal from a temperature sensing part 9 and a pressure sensing part 10, and this V is applied to a plasma generator 2.



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CLAIMS

[Claim(s)]
[Claim 1]In an exhaust emission control device of an internal-combustion engine which purifies exhaust gas by carrying out the placed opposite of two or more discharge sections across a channel through which exhaust gas of an internal-combustion engine flows, and generating discharge in said channel, An exhaust emission control device of an internal-combustion engine setting average electronic energy of an acceleration electron which makes it generate in said discharge section as a predetermined value corresponding to an energy value of an acceleration electron made to generate a chemical reaction required for purification of exhaust gas.
[Claim 2]An exhaust emission control device of the internal-combustion engine according to claim 1 setting up reaction energy which is sufficient for two or more sorts of radical generation containing O radical as a chemical reaction required for purification of exhaust gas become the average electronic energy of said predetermined value.
[Claim 3]An exhaust emission control device of the internal-combustion engine according to any one of claims 1 to 2 by which it is setting [as said predetermined value]-by pressure value applied between gap size [between said discharge sections] and said discharge section being set up-average electronic energy characterized.
[Claim 4]An exhaust emission control device of the internal-combustion engine according to any one of claims 1 to 3 which is provided with the following and characterized by said control means's changing a pressure value applied between said discharge sections based on a signal from said detection means, and doubling it with average electronic energy of said predetermined value.
A detection means to detect at least one environment information which shows a discharge environment condition of said discharge section.
A memory measure which memorizes beforehand relational data of said environment information of said discharge section used as average electronic energy of said predetermined value, and a pressure value applied between said discharge sections.
A control means which controls a pressure value applied between said discharge sections.

[Claim 5]A temperature detecting means which detects temperature of said discharge section which is said a part of detection means, The 1st memory measure that memorizes beforehand relational data of temperature of said discharge section used as average electronic energy of said predetermined value, and a pressure value applied between said discharge sections, An exhaust emission control device of the internal-combustion engine according to claim 4 having a control means which controls a pressure value applied between said discharge sections, and said control means's changing a pressure value applied between said discharge sections based on a signal from said temperature detecting means, and doubling with average electronic energy of said predetermined value.
[Claim 6]A pressure detection means to detect a pressure of said discharge section which is said a part of detection means, The 2nd memory measure that memorizes beforehand relational data of a pressure of said discharge section used as average electronic energy of said predetermined value, and a pressure value applied between said discharge sections, An exhaust emission control device of the internal-combustion engine according to claim 4 or 5 having a control means which controls a

pressure value applied between said discharge sections, and said control means's changing a pressure value applied between said discharge sections based on a signal from said pressure detection means, and doubling with average electronic energy of said predetermined value.
[Claim 7]The exhaust emission control device according to any one of claims 1 to 6, wherein average electronic energy of said predetermined value is set up among 5 to 7 eV.
[Claim 8]The exhaust emission control device according to any one of claims 1 to 6, wherein average electronic energy of said predetermined value is set as 6 eV.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the exhaust emission control device of the internal-combustion engine using especially a plasma generator about the exhaust emission control device of the internal-combustion engine which purifies the detrimental constituent in the exhaust gas discharged from an internal-combustion engine.
[0002]
[Description of the Prior Art]In recent years, the new emission-gas-purification art which purifies exhaust gas using spark discharge energy is studied. This art provides the plasma generator to which the placed opposite of two or more discharge sections was carried out across the channel through which the exhaust gas of an internal-combustion engine flows, and purifies exhaust gas by generating discharge in a channel as indicated, for example to JP,H5-59934,A. And having had the control means which controls the electric energy to a plasma generator to optimize the purification performance of the exhaust gas by discharge corresponding to the load change of an internal-combustion engine is indicated.
[0003]
[Problem(s) to be Solved by the Invention]However, in JP,H5-59934,A, although there is a description that it has a control means controlled to optimize electric energy, the concrete technique of this control means is not indicated. Since the situation where become a situation which runs short of the energy of the electron which is needed for purifying exhaust gas depending on the control means of the electric energy to a plasma generator, or a situation which becomes conversely superfluous [electronic energy], and an increase or exhaust gas purification performance of power consumption are not demonstrated arises, it is a problem.
[0004]The purpose of this invention is to provide the exhaust emission control device of the internal-combustion engine it becomes possible to supply electric power to a discharge section efficiently, and to raise the purification efficiency of exhaust gas in view of the above-mentioned point.
[0005]
[Means for Solving the Problem]In order to solve SUBJECT mentioned above, according to the exhaust emission control device of the internal-combustion engine of this invention according to claim 1, corresponding to an energy value of an acceleration electron made to generate a chemical reaction required for purification of exhaust gas, average electronic energy of an acceleration electron which makes it generate is set as a predetermined value.
[0006]That is, an artificer noted setting average electronic energy of an acceleration electron which makes it generate in a discharge section as a predetermined value so that it might correspond to an energy value of an acceleration electron made to generate a chemical reaction required for purification of exhaust gas. It is expressed as average electronic energy =exVx (lambda/Gap) mentioned above here, and is publicly known. A pressure value between discharge sections to which e carried out the placed opposite of an electron amount in discharging space (space between discharge sections which carried out the placed opposite), and the V (between surface parts of each discharge section which counters), and lambda show an electronic (e) mean free path and distance between discharge section surface parts to which the placed opposite of the Gap was carried out.

[0007]Thus, if this average electronic energy is set as a predetermined value in consideration of average electronic energy which can be found from each component e, V, and lambda in discharging space, and Gap, an exhaust emission control device of an internal-combustion engine it becomes possible to supply electric power to a discharge section efficiently, and to raise purification efficiency of exhaust gas can be provided.
[0008]According to the Claim 2 description of this invention, reaction energy which is sufficient for two or more sorts of radical generation containing O radical as a chemical reaction required for purification of exhaust gas was set up become the average electronic energy of a predetermined value.
[0009]Purification of exhaust gas is purified by harmless gas constituents by working so that two or more sorts of radicals containing O radical generated by applying electric power to a discharge section may promote oxidation reaction of a detrimental constituent in exhaust gas. That is, if reaction energy which is sufficient for two or more sorts of radical generation containing O radical which is needed for purification of exhaust gas is set up become the average electronic energy of a predetermined value, It is lost that a situation which runs short of energy of an electron which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas generate, or the situation where energy of an electron which makes two or more sorts of radicals which contain O radical conversely generate becomes superfluous occurs. Therefore, an exhaust emission control device of an internal-combustion engine it becomes possible to supply electric power efficiently and to raise purification efficiency of exhaust gas can be provided.
[0010]According to the Claim 3 description of this invention, it is considered as the setting [as a predetermined value]-by pressure value applied between gap size [between discharge sections] and discharge section being set up-average electronic energy feature.
[0011]Since it is expressed as average electronic energy =exVx (lambda/Gap), If pressure value (V) added between a gap size (Gap: distance between discharge section surface parts which carried out the placed opposite) between discharge sections, and a discharge section is adjusted, Setting out of average electronic energy used as energy of an electron which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas generate is easily made to a predetermined value.
[0012]A detection means to detect at least one environment information which shows a discharge environment condition of a discharge section according to the Claim 4 description of this invention, A memory measure which memorizes beforehand relational data of environment information of a discharge section used as average electronic energy of a predetermined value, and a pressure value applied between discharge sections, It has a control means which controls a pressure value applied between discharge sections, and a control means changes a pressure value applied between discharge sections based on a signal from a detection means, and doubles it with average electronic energy of a predetermined value.
[0013]Thus, if a pressure value applied between discharge sections based on a signal from a detection means to detect at least one environment information which shows a discharge environment condition of a discharge section is changed and it doubles with average electronic energy of a predetermined value, average electronic energy can be doubled with a predetermined value corresponding to a discharge environment condition of a discharge section.
[0014]A temperature detecting means which detects temperature of a discharge section which is a part of detection means according to the Claim 5 description of this invention, The 1st memory measure that memorizes beforehand relational data of temperature of a discharge section used as average electronic energy of a predetermined value, and a pressure value applied between discharge sections, It has a control means which controls a pressure value applied between discharge sections, and a control means changes a pressure value applied between discharge sections based on a signal from a temperature detecting means, and doubles it with average electronic energy of a predetermined value.
[0015]Here, the electronic (e) mean free path lambda changes according to change of temperature of a discharge section, and it is known that there is fixed correlation. Then, if a pressure value which memorizes beforehand relational data of temperature of a discharge section and a pressure value applied between discharge sections to the 1st memory measure, and a control means applies

between discharge sections based on a signal from a temperature detecting means which detects temperature of a discharge section is changed, It can double with average electronic energy of a predetermined value corresponding to change of temperature of a discharge section.
[0016]A pressure detection means to detect a pressure of a discharge section which is a part of detection means according to the Claim 6 description of this invention, The 2nd memory measure that memorizes beforehand relational data of a pressure of a discharge section used as average electronic energy of a predetermined value, and a pressure value applied between discharge sections, It has a control means which controls a pressure value applied between discharge sections, and a control means changes a pressure value applied between discharge sections based on a signal from said pressure detection means, and doubles it with average electronic energy of a predetermined value.
[0017]Here, an electronic (e) mean free path (lambda) changes according to change of a pressure of a discharge section, and it is known that there is fixed correlation. Then, if a pressure value applied between discharge sections based on a signal from a pressure detection means by which relational data of a pressure of a discharge section and a pressure value applied between discharge sections is beforehand memorized to the 2nd memory measure, and a control means detects a pressure of a discharge section is changed, It can double with average electronic energy of a predetermined value corresponding to change of a pressure of a discharge section.
[0018]According to the Claim 7 description of this invention, average electronic energy of a predetermined value is set up among 5 (5 electron volts) to 7 eV (7 electron volts).
[0019]If average electronic energy is set up among 5 to 7 eV as reaction energy which is sufficient for two or more sorts of radical generation containing O radical which is needed for purification of exhaust gas, setting out of electric power which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas the neither more nor less generate will be attained.
[0020]According to the Claim 8 description of this invention, average electronic energy of a predetermined value is set as 6 eV (6 electron volts).
[0021]If average electronic energy is set as 6 eV as reaction energy which is sufficient for two or more sorts of radical generation containing O radical which is needed for purification of exhaust gas, setting out of electric power which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas the neither more nor less generate will be attained.
[0022]
[Embodiment of the Invention]Hereafter, the exhaust emission control device of the internal-combustion engine which is one embodiment of this invention is explained in detail with reference to Drawings. The vehicles which carry the diesel power plant as an example of an internal-combustion engine are equipped with the exhaust emission control device of the internal-combustion engine of this invention. And so that it may correspond to the energy value of the acceleration electron made to generate a chemical reaction required for purification of exhaust gas, An artificer is a thing which set this average electronic energy as a predetermined value paying attention to setting the average electronic energy of an acceleration electron which makes it generate in a discharge section as a predetermined value and to do, and is an exhaust emission control device of the internal-combustion engine which supplies electric power to a discharge section efficiently, and raises the purification efficiency of exhaust gas.
[0023]First, the composition of an exhaust emission control device is explained using drawing 6 and drawing 7. Drawing 6 is an outline lineblock diagram showing the exhaust-emission-control-device 1 whole of one embodiment of this invention. Drawing 7 is an outline lineblock diagram of the plasma generator shown in drawing 6.
[0024]The plasma generator 2 in which the exhaust emission control device 1 is arranged in the middle of the exhaust pipe 51 of the engine 50 which is an internal-combustion engine as shown in drawing 6, The high-voltage-power-supply generating part 4 which impresses the alternating current high voltage of high frequency to this plasma generator 2, The pressure detecting section 10 which detects the temperature of the discharge section in the plasma generator 2, The temperature detecting section 9 which detects the temperature of the discharge section in the plasma generator 2, and the control section 8 which controls the energization to a discharge section based on the signal from the temperature detecting section 9 and the pressure detecting section 10, It is

constituted by the DPF(Diesel Particulate Filter) 52 grade with a catalyst arranged in the exhaust gas downstream position of the plasma generator 2.

[0025]The above-mentioned temperature detecting section 9 and the pressure detecting section 10 are a part of detection means to detect the environment information which shows the discharge environment condition of a discharge section, for example, the pressure and temperature in a discharge section are fixed to a measurable position, without being influenced by the plasma generated when it energizes to a discharge section. And the current supply for operating the high-voltage-power-supply generating part 4 and the control section 8 is composition in which current supply is carried out by one of the key switch (IG switch) 11 of vehicles from the mounted battery 12. In the control section 8, it has the memory part 8a, and this memory part 8a constitutes Claim 4 and the 1st and 2nd memory measure according to claim 5. The details of the memory part 8a are mentioned later.

[0026]Next, the composition of the plasma generator 2 is explained using drawing 7. In the plasma generator 2, two or more insulating substrates 5 are arranged in parallel with a prescribed interval, and the flat channel 6 through which exhaust gas passes between each insulating substrate 5 is formed. Each insulating substrate 5 is formed with heat-resistant insulators (for example, ceramics, such as alumina, glass, etc.). And in each insulating substrate 5, the electrode 3 for discharge formed of a printed conductor or plate conducting, respectively is embedded. The connecting terminal section 3a formed in one side of each of this electrode 3 is connected to the high-voltage-power-supply generator 4 which generates the high voltage alternating current voltage of high frequency, and another side is connected to the ground (ground potential) side. 7 shows the space between the discharge sections which carried out the placed opposite, i.e., the discharging space across which it faces between the electrodes 3.

[0027]Thus, each electrode 3 is made to counter across the channel 6 through which exhaust gas flows, it arranges, the alternating current high voltage of the high frequency from the high-voltage-power-supply generating part 4 is impressed to the electrode 3 of these plurality, plasma is generated, the electrode 3 and the insulating substrate 5 are united, and the discharge section according to claim 1 is constituted. And Gap shown in drawing 7 shows the distance between the discharge section surface parts which carried out the placed opposite, and shows the distance between insulating-substrate 5 surface parts with this gestalt.

[0028]Next, the composition of the control section 8 which controls the energization to a discharge section based on the signal from the temperature detecting section 9 and the pressure detecting section 10 is explained. The 1st memory part 8a as the 1st memory measure that memorizes beforehand the relational data of the temperature of the discharge section used as the average electronic energy of a predetermined value, and the pressure value applied between discharge sections in the control section 8, And it has the 2nd memory part 8b as the 2nd memory measure that memorizes beforehand the relational data of the pressure of the discharge section used as the average electronic energy of a predetermined value, and the pressure value applied between discharge sections.

[0029]And the data of the 1st memory part 8a that the control section 8 memorized, and the 2nd memory part 8b, It is the composition which sends a signal to the high-voltage-power-supply generating part 4 so that the pressure value applied between discharge sections from the signal from the temperature detecting section 9 and the pressure detecting section 10 may be computed, the pressure value applied between discharge sections based on this computed result may be changed and it may double with the average electronic energy of a predetermined value. The average electronic energy of the predetermined value mentioned above is mentioned later. The pressure value applied between discharge sections is a pressure value between the insulating-substrate 5 surface parts which show the pressure value between the discharge section surface parts which counter, and counter with this gestalt.

[0030]Drawing 8 is a characteristic figure showing an example of the voltage waveform applied to the discharge section in drawing 7, and the voltage applied between discharge section surface parts is a single-sided pressure value bordering on the Gnd level in the exchange impression voltage bordering on a Gnd level.

[0031]Next, an approximate account is carried out about the composition of DPF52 with a catalyst.

DPF52 with a catalyst has an ON side house, and this ON side house and ******** side house of the dead end, and it is making the septum support a catalyst while enabling passage of exhaust gas by using the septum of both ** as a porous ceramic material. The catalyst supported to a septum NOx in accordance with an exhaust gas presentation situation Occlusion, The NOx occlusion catalyst to discharge, the selection reduction catalyst which divides NOx into N_2 and O_2 by reducible components, such as HC in exhaust gas, CO, and H_2, Which catalyst of the oxidation catalyst which carries out purifying treatment of the detrimental constituent of HC, CO, the three-way catalyst that carries out purifying treatment of the three detrimental constituents of NOx simultaneously and HC, and CO is chosen, or it is used combining two or more catalysts.

[0032]Next, a view, a method, etc. of setting the average electronic energy of an acceleration electron which makes it generate in a discharge section as a predetermined value are explained below so that it may correspond to the energy value of the acceleration electron made to generate a chemical reaction required for purification of exhaust gas.

[0033]First, average electronic energy is explained using drawing 1 and drawing 2. Drawing 1 is an explanatory view explaining average electronic energy. Drawing 2 is an explanatory view showing the electronic energy distribution in the discharging space 7. As shown in drawing 1, Gap is set up as a distance between the surface parts of the discharge section (this gestalt each insulating substrate 5) which counters, and the voltage of the pressure value V is impressed among both discharge sections. And at this time, two or more e(electron) 20a which can be set at the discharging space 7 across which it faced among both discharge sections, and 20b have each free path lambda 1 with variation, and lambda 2, and collide with the gas molecules 21a and 21b.

[0034]The average electronic energy in this discharging space 7 is expressed as exVx (lambda/Gap), and is publicly known. An electron amount [in / in e in a front type / discharging space (space between the discharge sections which carried out the placed opposite)], the pressure value with which it is impressed between the discharge sections to which the placed opposite of the V was carried out (between the surface parts of each discharge section which counters), and lambda show an electronic (e) mean free path and the distance between the discharge section surface parts to which the placed opposite of the Gap was carried out.

[0035]Thus, if this average electronic energy is set as a predetermined value in consideration of the average electronic energy which can be found from each component e, V, and lambda in the discharging space 7, and Gap, it will become the exhaust emission control device 1 of the internal-combustion engine it becomes possible to supply electric power to a discharge section efficiently, and to raise the purification efficiency of exhaust gas. Setting out of the electric power which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas the neither more nor less by setting up this average electronic energy among 5 to 7 eV generate is attained. Electric power is most efficiently set up by setting it as 6 eV (6 electron volts) which is a mean value of 5 to 7 eV mentioned above, and two or more sorts of radicals containing O radical are made to generate in this embodiment.

[0036]Since the electron (e) has each free path lambda 1 with variation, and lambda 2, it shows electronic energy distribution as shown in drawing 2. The graph horizontal axis of drawing 2 is an indexation indicated value of the electronic energy value by the free path (lambda) length difference in an electron (e) here, and a graph vertical axis is a frequency value which shows the free path length distribution of two or more electrons (e) corresponding to a horizontal axis. That is, the part of the horizontal axis 1A in drawing 2 shows a mean free path (lambda), and sets it as 6 eV as the electronic energy computed based on this mean free path (lambda), i.e., average electronic energy.

[0037]Here, in order to be referred to as 6 eV of the predetermined value which mentioned average electronic energy above, as shown in drawing 3, it can set up by conformity with the distance (Gap) between discharge section surface parts, and pressure value (V) impressed between the surface parts of each discharge section which counters. Drawing 3 is a characteristic figure showing the relation between the discharge Gap and impressed electromotive force. Ultimate-lines (**) in drawing 3 shows the relation between the distance (Gap) between the discharge section surface parts which satisfy 6 eV as a predetermined temperature in the discharging space 7, and average electronic energy under pressure conditions, and pressure value (V) impressed between the surface parts of

each discharge section which counters.

[0038]It is known that an electronic (e) free path (lambda) will change with the type of gas in the discharging space 7, temperature, pressures, etc. Then, in order for average electronic energy to be 6 eV of a predetermined value, as shown in drawing 4, it can set up by conformity with the temperature in the discharging space 7, and pressure value (V) impressed between the surface parts of each discharge section which counters. Drawing 4 is a characteristic figure showing the relation of the temperature and impressed electromotive force in the discharging space 7 with which it is satisfied of the average electronic energy of a predetermined value. Ultimate-lines (**) in drawing 4 shows the relation between the temperature in the discharging space 7 with which it is satisfied of 6 eV as average electronic energy under the distance (Gap) setups between the discharge section surface parts in the discharging space 7, and pressure value (V) impressed between the surface parts of each discharge section which counters.

[0039]As shown in drawing 5, in order for average electronic energy to be 6 eV of a predetermined value, it can set up by conformity with the pressure in the discharging space 7, and pressure value (V) impressed between the surface parts of each discharge section which counters. Drawing 5 is a characteristic figure showing the relation of the pressure and impressed electromotive force in the discharging space with which it is satisfied of the average electronic energy of a predetermined value. Ultimate-lines (**) in drawing 5 shows the relation between the pressure in the discharging space 7 with which it is satisfied of 6 eV as average electronic energy under the temperature setting conditions in the discharging space 7, and pressure value (V) impressed between the surface parts of each discharge section which counters.

[0040]Relational data of 3 yuan with pressure value (V) impressed between the temperature in the discharging space 7 with which it is satisfied of 6 eV of average electronic energy mentioned above, the pressure in the discharging space 7, and the surface part of each discharge section which counters is beforehand stored in the 1st memory part 8a in the control section 8 as map data. And if a signal is respectively outputted to the control section 8 from the temperature detecting section 9 and the pressure detecting section 10, pressure value (V) impressed between the surface parts of each discharge section which counters using the 3 yuan map data stored in the 1st memory part 8a within the control section 8 will be computed.

[0041]An operation of the exhaust emission control device 1 constituted as mentioned above is explained below. When the exhaust gas which the engine 50 started and contained detrimental constituents, such as gaseous pollutants, such as NOx, and particulate matter (PM), is led to the plasma generator 2 via the exhaust pipe 51, According to the instructions from the control section 8, the high-voltage-power-supply generator 4 impresses the high voltage alternating current voltage of high frequency to two or more electrodes 3 which counter across each channel 6.

[0042]Pressure value (V) of the high voltage alternating current voltage of this high frequency is computed using the 3 yuan map data stored in the 1st memory part 8a within the control section 8 based on the signal respectively outputted to the control section 8 from the temperature detecting section 9 and the pressure detecting section 10.And the high-voltage-power-supply generator 4 is ordered the control section 8 so that it may become pressure value (V) computed between the surface parts of each discharge section which counters, and the high voltage alternating current voltage of high frequency is impressed to the electrode 3.

[0043]When the high voltage alternating current voltage of this high frequency is impressed to the electrode 3 and discharge occurs between discharge sections, the oxygen molecule in exhaust gas and the acceleration electron e by discharge react, and two or more sorts of radicals containing O radical (O*) are generated. And this O radical (O*) and nitric oxide (NO) in exhaust gas join together, and nitrogen dioxide (NO_2) is generated.

[0044]Here, purification of the particulate matter (PM) in the exhaust gas which is a detrimental constituent is divided roughly into the soot (SOOT) which uses carbon (C) as the main ingredients, and the unburnt glow object (S. O.F.) which uses hydrocarbon (HC) as the main ingredients. It reacts, as it is indicated in a following formula as this carbon (C) and hydrocarbon (HC), and the nitrogen dioxide (NO_2) generated by discharge.

[0045]In the case of soot (SOOT), it is set to $C+NO_2 \rightarrow CO_2+NO$, and, in the case of an unburnt glow

object (S. O.F.), reacts like $HC+NO_2->CO_2+H_2O+NO$. Since particulate matter (PM) and the nitrogen dioxide (NO_2) generated by discharge react also under low temperature environment, it is effective in a diesel power plant with low emission temperature. Such a reaction is generated by the septum of DPF32 with a catalyst arranged in the exhaust gas downstream position of the plasma generator 2 and the plasma generator 2.

[0046]Next, the cleaning effect of the nitrogen oxides (NOx) of the gaseous contaminant which is a detrimental constituent is explained. Nitrogen oxides (NOx) are conjugated compounds of nitrogen dioxide (NO_2) and nitric oxide (NO), Nitric oxide (NO) in these nitrogen oxides (NOx) and the nitric oxide (NO) by which it was generated in the reaction process of particulate matter (PM) are oxidized by O radical (O*) generated by discharge, and nitrogen dioxide (NO_2) is made to generate. And as shown in a following formula, the reduction reaction of the nitrogen dioxide (NO_2) is carried out, and it serves as harmless gas (CO_2, N_2) and water, and is discharged. Hydrocarbon (HC) which is a reducing agent is contained in exhaust gas as a part for unburnt calcination. The reduction reaction type of nitrogen dioxide (NO_2) is set to $NO_2+HC->N_2+CO_2+H_2O$, and is purified by harmless gas.

[0047]Thus, purification of exhaust gas is purified by harmless gas constituents by working so that two or more sorts of radicals containing O radical generated by applying electric power to a discharge section may promote oxidation reaction of the detrimental constituent in exhaust gas. By that is, the thing to consider as the exhaust emission control device 1 provided with the control section 8 which sets up the reaction energy which is sufficient for two or more sorts of radical generation containing O radical which is needed for purification of exhaust gas become the average electronic energy of a predetermined value. It is lost that the situation which runs short of the energy of the electron which makes two or more sorts of radicals containing O radical which is needed for purifying exhaust gas generate, or the situation where the energy of the electron which makes two or more sorts of radicals which contain O radical conversely generate becomes superfluous occurs. Therefore, the exhaust emission control device 1 of the internal-combustion engine it becomes possible to supply electric power efficiently and to raise the purification efficiency of exhaust gas can be provided.

[0048]Next, the procedure of the energization control to the discharge section which the control section 8 performs is explained based on the flow chart shown in drawing 9. If the engine 50 starts by one of the key switch (IG switch) 11 of vehicles in S10 (S expresses a step) first, the control section 8 will receive the signal (temperature data and pressure data) from the temperature detecting section 9 and the pressure detecting section 10 (S20). Subsequently, in S30, the control section 8 receives a signal respectively from the temperature detecting section 9 and the pressure detecting section 10, and computes pressure value (V) impressed between the surface parts of each discharge section which counters the 1st memory part 8a in the control section 8 using the 3 yuan map data memorized beforehand. And in S40, the high-voltage-power-supply generator 4 is ordered the control section 8 so that it may become computed pressure value (V), the high-voltage-power-supply generator 4 impresses the high voltage alternating current voltage of high frequency to two or more electrodes 3 which counter across each channel 6, and it carries out the end of an end of the processing concerned.

[0049]Although this embodiment showed the discharge section with which the electrode 3 and the insulating substrate 5 were united, when a discharge section comprises only the electrode 3, average electronic energy is called for in consideration of pressure value (V) impressed to the distance (Gap) between the surface parts of each electrode 3 which counters.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an explanatory view explaining average electronic energy.
[Drawing 2]It is an explanatory view showing the electronic energy distribution in the discharging space 7.
[Drawing 3]It is a characteristic figure showing the relation between the discharge Gap and impressed electromotive force.
[Drawing 4]It is a characteristic figure showing the relation of the temperature and impressed electromotive force in the discharging space 7 with which it is satisfied of the average electronic energy of a predetermined value.
[Drawing 5]It is a characteristic figure showing the relation of the pressure and impressed electromotive force in the discharging space 7 with which it is satisfied of the average electronic energy of a predetermined value.
[Drawing 6]It is an outline lineblock diagram showing the exhaust-emission-control-device 1 whole of one embodiment of this invention.
[Drawing 7]It is an outline lineblock diagram of the plasma generator 2 shown in drawing 6.
[Drawing 8]It is a characteristic figure showing an example of the voltage waveform applied to the discharge section in drawing 7.
[Drawing 9]It is a flow chart which shows the energization control to the discharge section which the control section 8 performs.
[Description of Notations]
1 Exhaust emission control device
2 Plasma generator
3 Electrode (a part of discharge section is constituted)
5 Insulating substrate (a part of discharge section is constituted)
6 Channel
8 Control section (control means)
8a Memory part (the 1st memory measure and the 2nd memory measure: constitute a part of memory measure)
9 Temperature detecting section (temperature detecting means: constitute a part of detection means)
10 Pressure detecting section (pressure-detection means: constitute a part of detection means)

[Translation done.]

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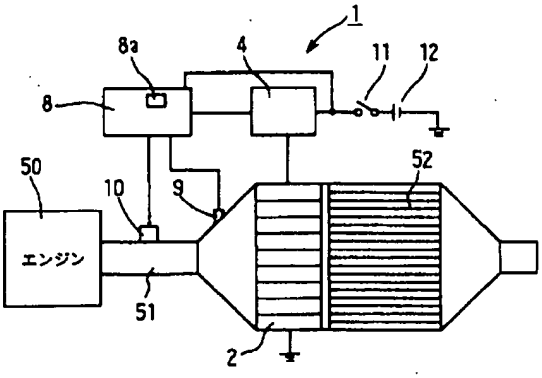
(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】
【課題】　効率的に放電部へ電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置１を提供する。
【解決手段】　放電場における各構成要素ｅ（電子量）、Ｖ（対向する各放電部の表面部間に印加する電圧値）、λ（電子の自由行程）、Ｇａｐ（対向する各放電部の表面部間距離）から求まる平均電子エネルギを考慮し、かつこの平均電子エネルギを排ガスの浄化に必要となるＯラジカルを含む複数種のラジカルの生成に足りる反応エネルギとして平均電子エネルギを６ｅＶに設定する制御部８を有する。例えば、制御部８は予め第１メモリ部８ａに格納した平均電子エネルギ６ｅＶを満足する放電場７における温度、圧力、およびＶとのマップデータと、温度検知部９および圧力検知部１０からの各信号とから平均電子エネルギ６ｅＶとなるＶを求め、プラズマ発生装置２にこのＶを印加する。



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【特許請求の範囲】

【請求項１】　内燃機関の排ガスが流れる流路を挟んで複数の放電部を対向配置させ、前記流路内で放電を発生させることで排ガスを浄化する内燃機関の排気浄化装置において、

排ガスの浄化に必要な化学反応を発生させる加速電子のエネルギ値に対応して、前記放電部にて発生させる加速電子の平均電子エネルギを所定値に設定することを特徴とする内燃機関の排気浄化装置。

【請求項２】　排ガスの浄化に必要な化学反応として、Ｏラジカルを含む複数種のラジカルの生成に足りる反応エネルギを前記所定値の平均電子エネルギとなるように設定したことを特徴とする請求項１に記載の内燃機関の排気浄化装置。

【請求項３】　前記放電部間の隙間寸法および前記放電部間に加える電圧値が設定されることで平均電子エネルギを前記所定値に設定したこと特徴とする請求項１ないし請求項２のいずれか１項に記載の内燃機関の排気浄化装置。

【請求項４】　前記放電部の放電環境状態を示す少なくとも１つの環境情報を検知する検知手段と、

前記所定値の平均電子エネルギとなる前記放電部の前記環境情報と前記放電部間に加える電圧値との関係データを予め記憶する記憶手段と、

前記放電部間に加える電圧値を制御する制御手段とを備え、

前記制御手段は、前記検知手段よりの信号に基づき前記放電部間に加える電圧値を可変して前記所定値の平均電子エネルギに合せることを特徴とする請求項１ないし請求項３のいずれか１項に記載の内燃機関の排気浄化装置。

【請求項５】　前記検知手段の一部である前記放電部の温度を検知する温度検知手段と、

前記所定値の平均電子エネルギとなる前記放電部の温度と前記放電部間に加える電圧値との関係データを予め記憶する第１記憶手段と、

前記放電部間に加える電圧値を制御する制御手段とを備え、

前記制御手段は、前記温度検知手段よりの信号に基づき前記放電部間に加える電圧値を可変して前記所定値の平均電子エネルギに合せることを特徴とする請求項４に記載の内燃機関の排気浄化装置。

【請求項６】　前記検知手段の一部である前記放電部の圧力を検知する圧力検知手段と、

前記所定値の平均電子エネルギとなる前記放電部の圧力と前記放電部間に加える電圧値との関係データを予め記憶する第２記憶手段と、

前記放電部間に加える電圧値を制御する制御手段とを備え、

前記制御手段は、前記圧力検知手段よりの信号に基づき

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前記放電部間に加える電圧値を可変して前記所定値の平均電子エネルギに合せることを特徴とする請求項４または請求項５に記載の内燃機関の排気浄化装置。

【請求項７】　前記所定値の平均電子エネルギは、５ｅＶから７ｅＶの間に設定されることを特徴とする請求項１ないし請求項６のいずれか１項に記載の排気浄化装置。

【請求項８】　前記所定値の平均電子エネルギは、６ｅＶに設定されることを特徴とする請求項１ないし請求項６のいずれか１項に記載の排気浄化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、内燃機関より排出される排ガス中の有害成分を浄化する内燃機関の排気浄化装置に関し、特にプラズマ発生装置を利用した内燃機関の排気浄化装置に関する。

【０００２】

【従来の技術】近年、放電エネルギを利用して排ガスを浄化する新たな排ガス浄化技術が研究されている。この技術は、例えば特開平５－５９９３４号公報に記載されているように、内燃機関の排ガスが流れる流路を挟んで複数の放電部を対向配置させたプラズマ発生装置を設け、流路内で放電を発生させることで排ガスを浄化するものである。そして、内燃機関の負荷変動に対応して放電による排ガスの浄化性能を最適化するようにプラズマ発生装置への電力量を制御する制御手段を備えたことが開示されている。

【０００３】

【発明が解決しようとする課題】しかし、特開平５－５９９３４号公報においては、電力量を最適化するように制御する制御手段を備えるとの記載があるものの、この制御手段の具体的手法が開示されていない。また、プラズマ発生装置への電力量の制御手段によっては、排ガスを浄化するのに必要となる電子のエネルギが不足する事態、または逆に電子のエネルギが過剰となる事態となって、消費電力の増加や排ガス浄化性能が発揮されない状況が生じるので問題である。

【０００４】本発明の目的は上記の点に鑑み、効率的に放電部へ電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置を提供することにある。

【０００５】

【課題を解決するための手段】上述した課題を解決するために、本発明の請求項１に記載の内燃機関の排気浄化装置によると、排ガスの浄化に必要な化学反応を発生させる加速電子のエネルギ値に対応して、発生させる加速電子の平均電子エネルギを所定値に設定することを特徴とする。

【０００６】つまり、排ガスの浄化に必要な化学反応を発生させる加速電子のエネルギ値に対応するように、放

電部にて発生させる加速電子の平均電子エネルギを所定値に設定することに、発明者は着目したのである。ここで、上述した平均電子エネルギ＝ｅ×Ｖ×（λ／Ｇａｐ）として表わされ、公知である。なお、ｅは放電場（対向配置させた放電部間における空間）における電子量、Ｖは対向配置させた放電部間（対向する各放電部の表面部間）における電圧値、λは電子（ｅ）の平均自由行程、Ｇａｐは対向配置させた放電部表面部間の距離を示す。

【０００７】このように、放電場における各構成要素ｅ、Ｖ、λ、Ｇａｐから求まる平均電子エネルギを考慮し、かつこの平均電子エネルギを所定値に設定すれば、効率的に放電部へ電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置を提供できる。

【０００８】本発明の請求項２記載によると、排ガスの浄化に必要な化学反応として、Ｏラジカルを含む複数種のラジカルの生成に足りる反応エネルギを所定値の平均電子エネルギとなるように設定したことを特徴とする。

【０００９】排ガスの浄化は、放電部に電力を加えることで発生するＯラジカルを含む複数種のラジカルが排ガス中の有害成分の酸化反応を促進させるように働くことで無害なガス成分に浄化される。つまり、排ガスの浄化に必要となるＯラジカルを含む複数種のラジカルの生成に足りる反応エネルギを所定値の平均電子エネルギとなるように設定すれば、排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電子のエネルギが不足する事態、または逆にＯラジカルを含む複数種のラジカルを生成させる電子のエネルギが過剰となる事態が発生することが無くなる。よって、効率的に電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置を提供できる。

【００１０】本発明の請求項３記載によると、放電部間の隙間寸法および放電部間に加える電圧値が設定されることで平均電子エネルギを所定値に設定したこと特徴とする。

【００１１】平均電子エネルギ＝ｅ×Ｖ×（λ／Ｇａｐ）として表わされるので、放電部間の隙間寸法（Ｇａｐ：対向配置させた放電部表面部間の距離）、および放電部間に加える電圧値（Ｖ）を調整すれば、排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電子のエネルギとなる平均電子エネルギの設定を容易に所定値にできる。

【００１２】本発明の請求項４記載によると、放電部の放電環境状態を示す少なくとも１つの環境情報を検知する検知手段と、所定値の平均電子エネルギとなる放電部の環境情報と放電部間に加える電圧値との関係データを予め記憶する記憶手段と、放電部間に加える電圧値を制御する制御手段とを備え、制御手段は、検知手段よりの信号に基づき放電部間に加える電圧値を可変して所定値の平均電子エネルギに合せることを特徴とする。

【００１３】このように、放電部の放電環境状態を示す少なくとも１つの環境情報を検知する検知手段よりの信号に基づき放電部間に加える電圧値を可変して所定値の平均電子エネルギに合せれば、放電部の放電環境状態に対応して平均電子エネルギを所定値に合せることができる。

【００１４】本発明の請求項５記載によると、検知手段の一部である放電部の温度を検知する温度検知手段と、所定値の平均電子エネルギとなる放電部の温度と放電部間に加える電圧値との関係データを予め記憶する第１記憶手段と、放電部間に加える電圧値を制御する制御手段とを備え、制御手段は、温度検知手段よりの信号に基づき放電部間に加える電圧値を可変して所定値の平均電子エネルギに合せることを特徴とする。

【００１５】ここで、電子（ｅ）の平均自由行程λは、放電部の温度の変化に応じて変化し、既定の相関関係があることが知られている。そこで、予め放電部の温度と放電部間に加える電圧値との関係データを第１記憶手段に記憶しておき、制御手段が放電部の温度を検知する温度検知手段よりの信号に基づき放電部間に加える電圧値を可変すれば、放電部の温度の変化に対応して所定値の平均電子エネルギに合せることができる。

【００１６】本発明の請求項６記載によると、検知手段の一部である放電部の圧力を検知する圧力検知手段と、所定値の平均電子エネルギとなる放電部の圧力と放電部間に加える電圧値との関係データを予め記憶する第２記憶手段と、放電部間に加える電圧値を制御する制御手段とを備え、制御手段は、前記圧力検知手段よりの信号に基づき放電部間に加える電圧値を可変して所定値の平均電子エネルギに合せることを特徴とする。

【００１７】ここで、電子（ｅ）の平均自由行程（λ）は、放電部の圧力の変化に応じて変化し、既定の相関関係があることが知られている。そこで、予め放電部の圧力と放電部間に加える電圧値との関係データを第２記憶手段に記憶しておき、制御手段が放電部の圧力を検知する圧力検知手段よりの信号に基づき放電部間に加える電圧値を可変すれば、放電部の圧力の変化に対応して所定値の平均電子エネルギに合せることができる。

【００１８】本発明の請求項７記載によると、所定値の平均電子エネルギは、５ｅＶ（５エレクトロン・ボルト）から７ｅＶ（７エレクトロン・ボルト）の間に設定されることを特徴とする。

【００１９】排ガスの浄化に必要となるＯラジカルを含む複数種のラジカルの生成に足りる反応エネルギとして平均電子エネルギを５ｅＶから７ｅＶの間に設定すれば、過不足なく排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電力の設定が可能となる。

【００２０】本発明の請求項８記載によると、所定値の

平均電子エネルギは、６ｅＶ（６エレクトロン・ボルト）に設定されることを特徴とする。

【００２１】排ガスの浄化に必要となるＯラジカルを含む複数種のラジカルの生成に足りる反応エネルギとして平均電子エネルギを６ｅＶに設定すれば、最も過不足なく排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電力の設定が可能となる。

【００２２】

【発明の実施の形態】以下、本発明の一実施形態である内燃機関の排気浄化装置を、図面を参照して詳細に説明する。なお、本発明の内燃機関の排気浄化装置は、内燃機関の一例としてのディーゼルエンジンを搭載した車両に備えられる。そして、排ガスの浄化に必要な化学反応を発生させる加速電子のエネルギ値に対応するように、放電部にて発生させる加速電子の平均電子エネルギを所定値に設定することに発明者は着目し、この平均電子エネルギを所定値に設定するすることで、効率的に放電部へ電力を供給して排ガスの浄化効率を高める内燃機関の排気浄化装置である。

【００２３】先ず、図６および図７を用いて、排気浄化装置の構成を説明する。図６は、本発明の一実施形態の排気浄化装置１全体を示す概略構成図である。図７は、図６中に示すプラズマ発生装置の概略構成図である。

【００２４】図６に示すように排気浄化装置１は、内燃機関であるエンジン５０の排気管５１の途中に配置されるプラズマ発生装置２と、このプラズマ発生装置２に高周波の交流高電圧を印加する高圧電源発生部４と、プラズマ発生装置２内の放電部の温度を検知する圧力検知部１０と、プラズマ発生装置２内の放電部の温度を検知する温度検知部９と、温度検知部９および圧力検知部１０よりの信号に基づいて放電部への通電を制御する制御部８と、プラズマ発生装置２の排ガス下流側位置に配置した触媒付きＤＰＦ（Ｄｉｅｓｅｌ　Ｐａｒｔｉｃｕｌａｔｅ　Ｆｉｌｔｅｒ）５２等により構成される。

【００２５】なお、上記した温度検知部９および圧力検知部１０は、放電部の放電環境状態を示す環境情報を検知する検知手段の一部であり、例えば放電部に通電した際に発生するプラズマの影響を受けずに放電部での圧力および温度を測定可能な位置に固定される。そして、高圧電源発生部４および制御部８を動作させるための電源供給は、車両のキースイッチ（ＩＧスイッチ）１１のオンによって車載バッテリー１２より電源供給される構成である。なお、制御部８内には、メモリ部８ａを備えており、このメモリ部８ａが請求項４および請求項５に記載の第１、第２記憶手段を構成している。なお、メモリ部８ａの詳細は後述する。

【００２６】次に図７を用いてプラズマ発生装置２の構成を説明する。プラズマ発生装置２内には、複数の絶縁基板５が所定間隔で平行に配置され、各絶縁基板５間に排ガスが通過する偏平な流路６が形成されている。各絶縁基板５は、耐熱性絶縁体（例えばアルミナ等のセラミック、ガラス等）で形成されている。そして、各絶縁基板５内には、それぞれ印刷導体又は導電板によって形成された放電用の電極３が埋め込まれている。この各電極３の一方に形成された接続端子部３ａは、高周波の高圧交流電圧を発生する高圧電源発生装置４に接続され、他方は、グランド（アース電位）側に接続されている。なお、７は、対向配置させた放電部間における空間、つまり電極３間で挟まれる放電場を示す。

【００２７】このように、排ガスが流れる流路６を挟んで各電極３を対向させて配置し、これら複数の電極３に高圧電源発生部４からの高周波の交流高電圧を印加しプラズマを発生させており、電極３および絶縁基板５が一体となって請求項１記載の放電部を構成している。そして、図７中に示すＧａｐは、対向配置させた放電部表面部間の距離を示しており、本形態では絶縁基板５表面部間の距離を示す。

【００２８】次に、温度検知部９および圧力検知部１０よりの信号に基づいて放電部への通電を制御する制御部８の構成について説明する。制御部８内には、所定値の平均電子エネルギとなる放電部の温度と放電部間に加える電圧値との関係データを予め記憶する第１記憶手段としての第１メモリ部８ａ、および所定値の平均電子エネルギとなる放電部の圧力と放電部間に加える電圧値との関係データを予め記憶する第２記憶手段としての第２メモリ部８ｂとを備えている。

【００２９】そして、制御部８は、記憶した第１メモリ部８ａおよび第２メモリ部８ｂのデータと、温度検知部９および圧力検知部１０よりの信号とから放電部間に加える電圧値を算出し、この算出結果に基づき放電部間に加える電圧値を可変して所定値の平均電子エネルギに合せるように高圧電源発生部４に信号を発信する構成である。なお、上述した所定値の平均電子エネルギについては、後述する。また、放電部間に加える電圧値とは、対向する放電部表面部間における電圧値を示し、本形態では対向する絶縁基板５表面部間における電圧値である。

【００３０】図８は、図７中の放電部に加える電圧波形の一例を示す特性図であり、放電部表面部間に加える電圧は、Ｇｎｄレベルを境に交流印加される電圧におけるＧｎｄレベルを境とした片側電圧値である。

【００３１】次に、触媒付きＤＰＦ５２の構成について概略説明する。触媒付きＤＰＦ５２は、行止まりの入側室と、この入側室と隣合う出側室とを有し、両室の隔壁を多孔質セラミック材として排ガスを通過可能とさせるとともに、隔壁に触媒を担持させている。なお、隔壁に担持する触媒は、排ガス組成状況にあわせてＮＯｘを吸蔵、排出するＮＯｘ吸蔵触媒、ＮＯｘを排ガス中のＨＣ、ＣＯ、H_2などの還元性成分によってN_2とO_2に分離する選択還元触媒、ＨＣ、ＣＯ、ＮＯｘの３つの有害成分を同時に浄化処理する３元触媒、およびＨＣ、ＣＯ

の有害成分を浄化処理する酸化触媒のいずれの触媒を選択するか、あるいは複数の触媒を組合わせて使用される。

【００３２】次に、排ガスの浄化に必要な化学反応を発生させる加速電子のエネルギ値に対応するように、放電部にて発生させる加速電子の平均電子エネルギを所定値に設定する考え方、方法等について以下説明する。

【００３３】先ず、平均電子エネルギについて、図１、図２を用いて、説明する。図１は、平均電子エネルギを説明する説明図である。図２は、放電場７における電子エネルギ分布を示す説明図である。図１に示すように、対向する放電部（本形態では、各絶縁基板５）の表面部間の距離としてＧａｐが設定され、両放電部間に電圧値Ｖの電圧が印加されている。そして、この時、両放電部間に挟まれた放電場７における複数のｅ（電子）２０ａ、２０ｂは、バラツキをもった各々の自由行程λ１、λ２を有してガス分子２１ａ、２１ｂに衝突する。

【００３４】この放電場７における平均電子エネルギは、ｅ×Ｖ×（λ／Ｇａｐ）として表わされ、公知である。なお、前式におけるｅは放電場（対向配置させた放電部間における空間）における電子量、Ｖは対向配置させた放電部間（対向する各放電部の表面部間）に印加される電圧値、λは電子（ｅ）の平均自由行程、Ｇａｐは対向配置させた放電部表面部間の距離を示す。

【００３５】このように、放電場７における各構成要素ｅ、Ｖ、λ、Ｇａｐから求まる平均電子エネルギを考慮し、かつこの平均電子エネルギを所定値に設定すれば、効率的に放電部へ電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置１となる。また、この平均電子エネルギを５ｅＶから７ｅＶの間に設定することで、過不足なく排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電力の設定が可能となる。本実施形態では、上述した５ｅＶから７ｅＶの中間値である６ｅＶ（６エレクトロン・ボルト）に設定することで最も効率よく電力を設定し、Ｏラジカルを含む複数種のラジカルを生成させる。

【００３６】また、電子（ｅ）はバラツキをもった各々の自由行程λ１、λ２を有していることから、図２に示すような電子エネルギ分布を示す。ここで、図２のグラフ横軸は、電子（ｅ）の自由行程（λ）長さ違いによる電子エネルギ値の指数化表示値であり、グラフ縦軸は、横軸に対応した複数の電子（ｅ）の自由行程長さ分布を示す度数値である。つまり、図２中の横軸１Ａの箇所が平均自由行程（λ）を示し、この平均自由行程（λ）を基に算出した電子エネルギ、つまり平均電子エネルギとして６ｅＶに設定するのである。

【００３７】ここで、平均電子エネルギを上述した所定値の６ｅＶとするには、図３に示すように放電部表面部間の距離（Ｇａｐ）と対向する各放電部の表面部間に印加する電圧値（Ｖ）との適合により設定できる。図３は、放電Ｇａｐと印加電圧との関係を示す特性図である。図３中の特性線（ロ）は、放電場７における所定の温度および圧力条件下での平均電子エネルギとして６ｅＶを満足する放電部表面部間の距離（Ｇａｐ）と対向する各放電部の表面部間に印加する電圧値（Ｖ）との関係を示す。

【００３８】なお、電子（ｅ）の自由行程（λ）は、放電場７におけるガス種、温度、および圧力等によって変化することが知られている。そこで、平均電子エネルギを所定値の６ｅＶとするには、図４に示すように放電場７における温度と対向する各放電部の表面部間に印加する電圧値（Ｖ）との適合により設定できる。図４は、所定値の平均電子エネルギを満足する放電場７における温度と印加電圧との関係を示す特性図である。図４中の特性線（ハ）は、放電場７における放電部表面部間の距離（Ｇａｐ）設定条件下での平均電子エネルギとして６ｅＶを満足する放電場７における温度と対向する各放電部の表面部間に印加する電圧値（Ｖ）との関係を示す。

【００３９】また、図５に示すように平均電子エネルギを所定値の６ｅＶとするには、放電場７における圧力と対向する各放電部の表面部間に印加する電圧値（Ｖ）との適合により設定できる。図５は、所定値の平均電子エネルギを満足する放電場における圧力と印加電圧との関係を示す特性図である。図５中の特性線（ニ）は、放電場７における温度設定条件下での平均電子エネルギとして６ｅＶを満足する放電場７における圧力と対向する各放電部の表面部間に印加する電圧値（Ｖ）との関係を示す。

【００４０】上述した平均電子エネルギ６ｅＶを満足する放電場７における温度、放電場７における圧力、および対向する各放電部の表面部間に印加する電圧値（Ｖ）との関係データを、予め制御部８内の第１メモリ部８ａに３元マップデータとして格納しておく。そして、温度検知部９および圧力検知部１０から制御部８へ各々信号が出力されると、制御部８内で第１メモリ部８ａに格納された３元マップデータを用いて、対向する各放電部の表面部間に印加する電圧値（Ｖ）を算出する。

【００４１】以上のように構成した排気浄化装置１の作用について、以下説明する。エンジン５０が始動されて、ＮＯｘ等のガス状汚染物質、および粒子状汚染物質（ＰＭ）等の有害成分を含んだ排ガスが排気管５１を介してプラズマ発生装置２に導かれる時には、制御部８からの指令に従い高圧電源発生装置４は各流路６を挟んで対向する複数の電極３に高周波の高圧交流電圧を印加する。

【００４２】この高周波の高圧交流電圧の電圧値（Ｖ）は、温度検知部９および圧力検知部１０から制御部８へ各々出力される信号に基づき、制御部８内で第１メモリ部８ａに格納された３元マップデータを用いて算出され

る。そして、制御部８は対向する各放電部の表面部間に算出された電圧値（Ｖ）となるように高圧電源発生装置４に指令して、高周波の高圧交流電圧が電極３に印加される。

【００４３】この高周波の高圧交流電圧が電極３に印加され、放電部間に放電が発生することにより、排ガス中の酸素分子と放電による加速電子ｅとが反応し、Ｏラジカル（Ｏ＊）を含む複数種のラジカルが生成される。そして、このＯラジカル（Ｏ＊）等と排ガス中の一酸化窒素（ＮＯ）とが結合し、二酸化窒素（NO_2）が生成される。

【００４４】ここで、有害成分である排ガス中の粒子状汚染物質（ＰＭ）の浄化は、炭素（Ｃ）を主成分とする煤（ＳＯＯＴ）、および炭化水素（ＨＣ）を主成分とする未燃焼体（Ｓ．Ｏ．Ｆ．）に大別される。この炭素（Ｃ）、および炭化水素（ＨＣ）と、放電により生成される二酸化窒素（NO_2）とは、次式に示すように反応する。

【００４５】煤（ＳＯＯＴ）の場合は、$C+NO_2 \rightarrow CO_2+NO$となり、未燃焼体（Ｓ．Ｏ．Ｆ．）の場合は、$HC+NO_2 \rightarrow CO_2+H_2O+NO$のように反応する。なお、粒子状汚染物質（ＰＭ）と放電により生成される二酸化窒素（NO_2）とは、低温環境下でも反応するので、排ガス温度の低いディーゼルエンジンにおいて有効である。このような反応は、プラズマ発生装置２とプラズマ発生装置２の排ガス下流側位置に配置した触媒付きＤＰＦ３２の隔壁で発生する。

【００４６】次に、有害成分であるガス状汚染物の窒素酸化物（ＮＯｘ）の浄化作用を説明する。窒素酸化物（ＮＯｘ）は、二酸化窒素（NO_2）と一酸化窒素（ＮＯ）の複合化合物であり、この窒素酸化物（ＮＯｘ）中の一酸化窒素（ＮＯ）、および粒子状汚染物質（ＰＭ）の反応過程で発生した一酸化窒素（ＮＯ）を放電により生成されるＯラジカル（Ｏ＊）により酸化させて二酸化窒素（NO_2）を生成させる。そして、二酸化窒素（NO_2）は、次式に示すように還元反応し、無害なガス（CO_2、N_2）、および水となって排出される。なお、還元剤である炭化水素（ＨＣ）は未燃焼成分として排ガス中に含まれている。二酸化窒素（NO_2）の還元反応式は、$NO_2+HC \rightarrow N_2+CO_2+H_2O$となり、無害なガスに浄化される。

【００４７】このように、排ガスの浄化は、放電部に電力を加えることで発生するＯラジカルを含む複数種のラジカルが排ガス中の有害成分の酸化反応を促進させるように働くことで無害なガス成分に浄化される。つまり、排ガスの浄化に必要となるＯラジカルを含む複数種のラジカルの生成に足りる反応エネルギを所定値の平均電子エネルギとなるように設定する制御部８を備えた排気浄化装置１とすることで、排ガスを浄化するのに必要となるＯラジカルを含む複数種のラジカルを生成させる電子のエネルギが不足する事態、または逆にＯラジカルを含む複数種のラジカルを生成させる電子のエネルギが過剰となる事態が発生することが無くなる。よって、効率的に電力を供給して排ガスの浄化効率を高めることが可能となる内燃機関の排気浄化装置１を提供できる。

【００４８】次に、制御部８が実行する放電部への通電制御の処理手順を図９に示すフローチャートに基づいて説明する。先ずＳ１０（Ｓはステップを表す）にて車両のキースイッチ（ＩＧスイッチ）１１のオンによりエンジン５０が始動されると、制御部８が温度検知部９および圧力検知部１０からの信号（温度データおよび圧力データ）を受信する（Ｓ２０）。次いで、Ｓ３０では、制御部８が温度検知部９および圧力検知部１０から各々信号を受信し、制御部８内の第１メモリ部８ａに予め記憶した３元マップデータを用いて、対向する各放電部の表面部間に印加する電圧値（Ｖ）を算出する。そして、Ｓ４０では、制御部８は算出された電圧値（Ｖ）となるように高圧電源発生装置４に指令し、高圧電源発生装置４は各流路６を挟んで対向する複数の電極３に高周波の高圧交流電圧を印加し、当該処理を一端終了する。

【００４９】なお、本実施形態では、電極３および絶縁基板５が一体となった放電部を示したが、電極３のみで放電部を構成される場合においては、対向する各電極３の表面部間の距離（Ｇａｐ）に印加する電圧値（Ｖ）を考慮して平均電子エネルギが求められる。

【図面の簡単な説明】

【図１】平均電子エネルギを説明する説明図である。

【図２】放電場７における電子エネルギ分布を示す説明図である。

【図３】放電Ｇａｐと印加電圧との関係を示す特性図である。

【図４】所定値の平均電子エネルギを満足する放電場７における温度と印加電圧との関係を示す特性図である。

【図５】所定値の平均電子エネルギを満足する放電場７における圧力と印加電圧との関係を示す特性図である。

【図６】本発明の一実施形態の排気浄化装置１全体を示す概略構成図である。

【図７】図６中に示すプラズマ発生装置２の概略構成図である。

【図８】図７中の放電部に加える電圧波形の一例を示す特性図である。

【図９】制御部８が実行する放電部への通電制御を示すフローチャートである。

【符号の説明】

１　排気浄化装置
２　プラズマ発生装置
３　電極（放電部の一部を構成）
５　絶縁基板（放電部の一部を構成）
６　流路
８　制御部（制御手段）

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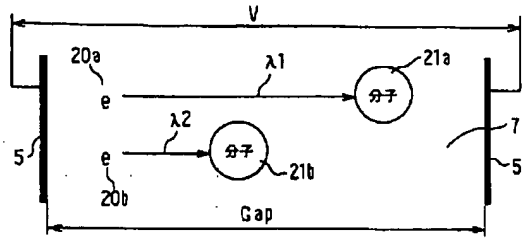
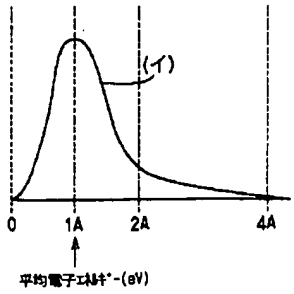
８ａ　メモリ部（第１記憶手段および第２記憶手段：記　＊成）
憶手段の一部を構成）
９　温度検知部（温度検知手段：検知手段の一部を構　＊　成）
１０　圧力検知部（圧力検知手段：検知手段の一部を構

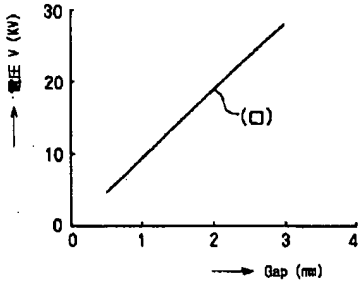
【図１】



【図２】



【図３】



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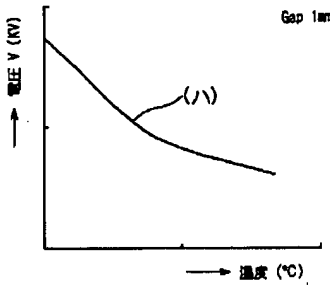

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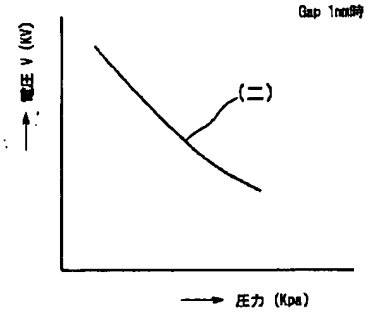

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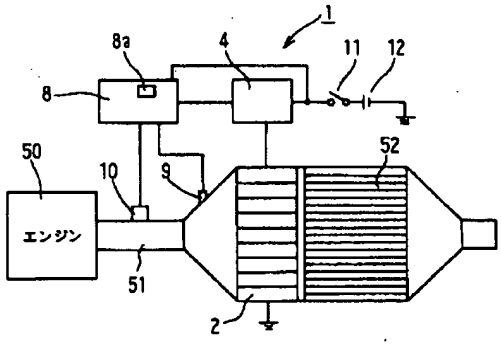

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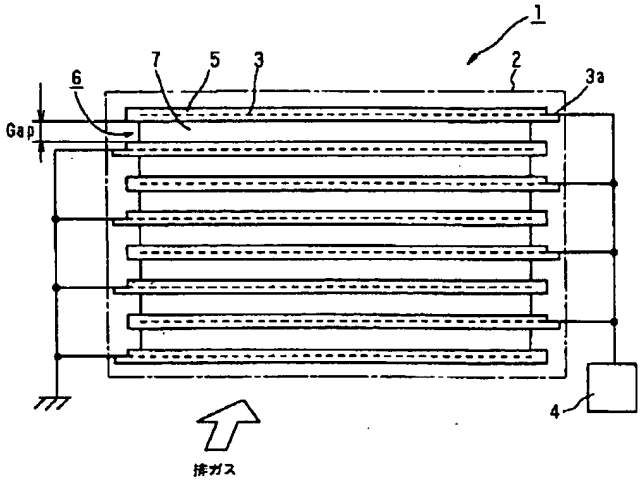

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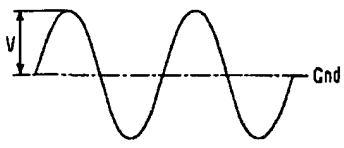
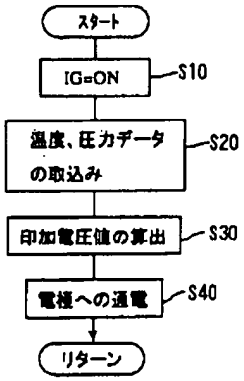


【図９】



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Ｆターム(参考) 3G091 AA02 AA18 AB02 AB03 AB05
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EA05 GA02 GB02 GB03 GB04
4G075 AA03 AA37 AA62 AA63 AA65
BA01 BA05 BA06 CA15 CA47
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